ISSN 1028-334X, Doklady Earth Sciences, 2007, Vol. 417A, No. 9, pp. 1359–1361. © Pleiades Publishing, Ltd., 2007.
Original Russian Text © L.A. Ivanova, V.Ya. Medvedev, M.V. Pochekunina, 2007, published in Doklady Akademii Nauk, 2007, Vol. 417, No. 3, pp. 382–384.

GEOCHEMISTRY

Specific Features of the Formation of Fayalite in Reduced Systems

L. A. Ivanova, V. Ya. Medvedev, and M. V. Pochekunina

Presented by Academician F.A. Letnikov November 3, 2006

Received November 14, 2006

DOI: 10.1134/S1028334X07090140

Processes of mineral formation in reduced fluid systems are among the most interesting aspects of experimental mineralogy. In these systems, ore and petrogenic components can be transferred in both hydrothermal and dry conditions, as was shown previously [1, 2]. The transfer of the most abundant rock-forming components (Si and Fe) in the H–O–N system (NH_3 25%, H_2 25–75%, H_2O 0–50%) was studied using the temperature gradient method at T = 500–700°C (gradient 50–100°C), P = 500–1000 bar, and duration 100–500 h. A model granite glass was placed into the lower part of the autoclave, while quartz and leucocratic granite samples in the form of polished bars (≈25 × 10 × 8 mm in size) were mounted in the upper part of stainless steel (1X18H9T) holders. The exoclave was filled with fluid of the required composition, which was produced either through the interaction of metallic Al with aqueous NH_4OH in the reactor module of the autoclave or in a special reactor and then was supplied along a hot pipe line in the exoclave. The experiments were conducted in both standard autoclaves and Ti liners to exclude interaction of the system with materials of the exoclave reactors. The phase composition of the fluid was preliminarily calculated using the Selector program complex and complete database. Anhydrous H–O–N gas systems were studied first.

Our experiments showed no significant transfer of components or formation of new phases under the given conditions. Addition of 1% HCl in the system promotes the transfer of Fe and crystallization of its α-modification over the entire studied temperature interval. Addition of 1% NaOH shows no significant

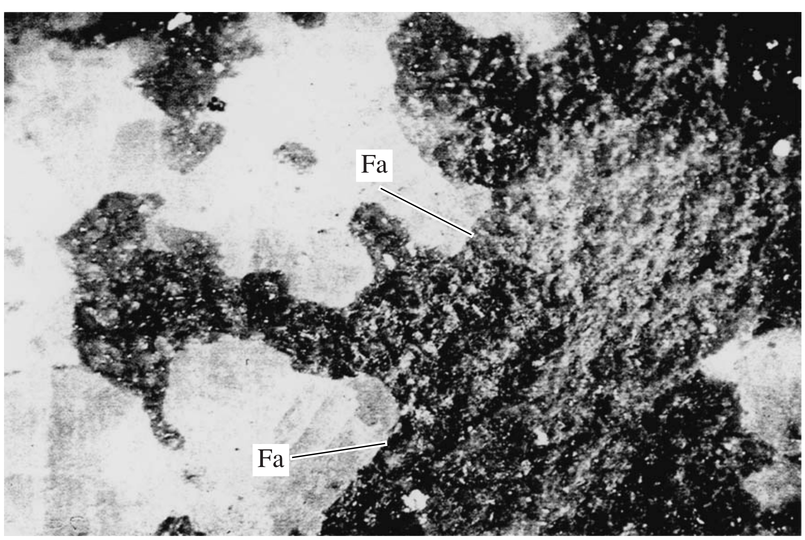

Fig. 1. Newly formed fayalite (Fa) on quartz grains in leucocratic granite (dark). Magn. 30.

*Institute of the Earth's Crust, Siberian Branch,
Russian Academy of Sciences, ul. Lermontova 128, Irkutsk, 664033 Russia; e-mail: med@crust.irk.ru*

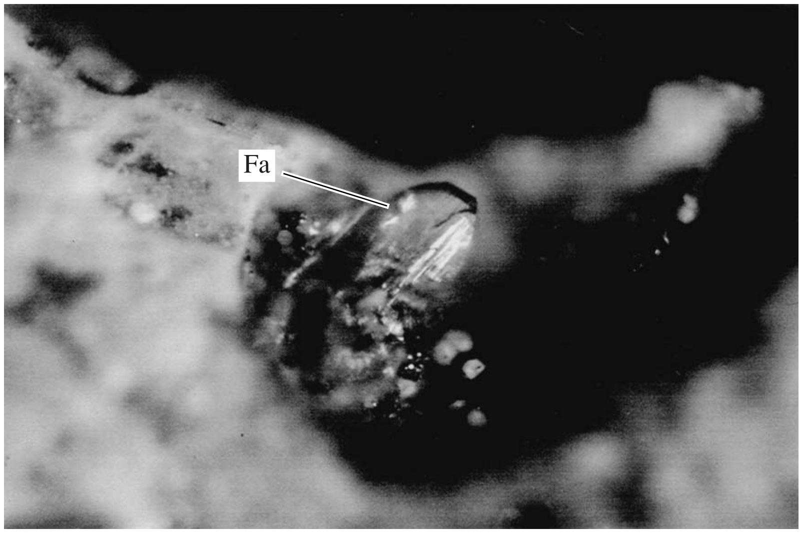

Fig. 2. Crystal of newly formed fayalite. Magn. 100

influence on the mineral formation. The substitution of NaCl for HCl leads to the formation of fayalite after quartz and quartz aggregates in leucocratic granites and Fe-bearing sample holders.

Experiments with quartz samples and quartz aggregates in leucocratic granite yielded brownish yellow coatings (0.15–0.28 mm thick) of closely intergrown platy crystals of the newly formed fayalite (Fig. 1). The crystals (up to 0.32 mm long and 0.014 mm thick) show mainly pinacoid faces, while the subordinate prismatic forms are poorly developed (Fig. 2). In the sample holders, fayalite is represented by prismatic (occasionally short-prismatic) crystals up to 0.28 mm long. The unit cell parameters of the synthesized fayalite almost correspond to the reference samples and do not depend on the growth matrix: a = 4.816 Å, b = 10.469 Å, c = 6.099 Å, V = 307.5 (Å^3). However, the morphology of the newly formed fayalite depends on the composition of the base (quartz or Fe-bearing holders).

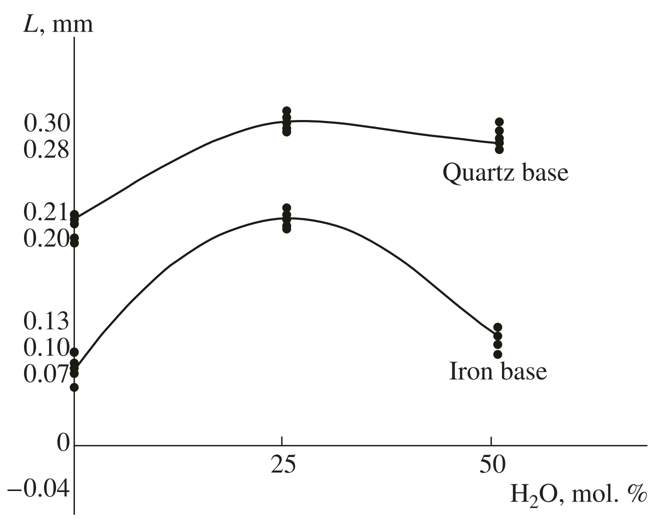

Fig. 3. Dependence of fayalite growth on the H_2O concentration in H–O–N fluid at NH_3 = 25%, T = 500°C, P = 1000 atm, and τ = 120 h.

To study the influence of H_2O content on the kinetics of fayalite growth, additional experiments were conducted with the H_2O mole fraction in fluid up to 50% (Fig. 3).

These experiments showed the following dynamics of fayalite growth:

1. The growth rate of fayalite is high (up to 0.002 mm/h at T = 500°C), whereas experiments on its diffusion growth [3] at significantly higher temperatures (1200°C) yielded only 0.0001 mm/h.

2. The difference in the growth rate of fayalite on different bases (quartz and iron) is insignificant.

3. The growth of certain faces of the newly formed fayalite is significantly influenced by the composition of the parent substrate. For example, mainly platy crystals with well-developed pinacoid faces are formed after quartz, while prismatic and short-prismatic crystals are formed on Fe-bearing holders, indicating a significant adsorption influence of components of the medium on the crystal shape.

4. Fayalite is formed only in the presence of NaCl in the studied temperature and pressure range.

The growth of fayalite from the gas phase due to precipitation on quartz and Fe-bearing holders depends on the influx of Fe and Si, respectively, by fluid.

The data obtained are consistent with the concept of Marakushev [4] about the formation of Fe-olivine under conditions of high alkalinity and low pressure (association with low-depth complexes). Fayalite is commonly found in pegmatoid formations, miarolitic cavities in alkali granites, and granitic pegmatite veins. In terms of formation conditions, fayalite rocks belong to the highest temperature greisen facies [5], which corresponds to our experimental parameters. Fayalite greisens related to felsic granitic intrusions are of great interest as proxies of the final phase of rare metal intrusions. The appearance of fayalite in the granitic rocks [6] is related to high partial pressure of hydrogen and significant predominance of the Fe^{2+} content over Mg.

Thus, our experiments showed that Si and Fe can be transferred to the reduced part of the H–O–N system in the presence of NaCl under both hydrothermal and anhydrous conditions, confirming the possibility of the existence of fayalite-bearing felsic rocks.

ACKNOWLEDGMENTS

We thank academician F.A. Letnikov for constant attention to experimental investigations and discussion of results.

This work was supported by the Russian Foundation for Basic Research, project no. 04-05-64869.

REFERENCES

1. F. A. Letnikov, Geol. Ore Dep. **43** 259 (2001) [Geol. Rudn. Mestorozhd. **43**, 291 (2001)].
2. V. Ya. Medvedev and L. A. Ivanova, Dokl. Earth Sci. **403**, 782 (2005) [Dokl. Akad. Nauk, **403**, 93 (2005)].
3. D. K. Fisher and S. J. Mackwell, Phys. Chem. Miner. **21**, 156 (1994).
4. A. A. Marakushev, I. A. Tararin, and B. L. Zalishchak, *Mineral Facies and Their Ore Potential* (Nauka, Moscow, 1966), pp. 5–72 [in Russian].
5. O. S. Gracheva, Zap. Vses. Mineral. O-va **95**, 583 (1966).
6. I. V. Ginzburg, G. A. Lisitsina, A. T. Sadikova et al., Tr. Miner. Muzeya **13**, 16 (1962).